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14. ABSTRACT An acoustical assessment was performed on the Combat Arms Firing Range at Patrick AFB in July 2013. It was determined that the noise in the firing range did not meet the definition of impulse noise in AFOSH Standard 48-20 due to acoustical reflections. Therefore, it was recommended that acoustical absorption be added to these side walls to reduce the reverberant field.					
15. SUBJECT TERMS Impulse noise, impact noise, decay time, CATM, firing range, hearing, acoustics, noise, firearms					
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DEPARTMENT OF THE AIR FORCE
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)
WRIGHT-PATTERSON AFB OH

26 September 2013

MEMORANDUM FOR 45 AMDS/SGPB
ATTN: MAJ KRYSTYN CLARK
1381 S. PATRICK DRIVE
PATRICK AFB, FL 32925

FROM: USAFSAM/OEC
2510 Fifth Street
Wright-Patterson AFB, OH 45433

SUBJECT: Consultative Letter, AFRL-SA-WP-CL-2013-0018, Acoustical Evaluation of
Combat Arms Firing Range, Patrick AFB, Florida

1. INTRODUCTION:

a. *Purpose:* On 15-19 July 2013, the United States Air Force School of Aerospace Medicine, Consultative Services Division (USAFSAM/OEC), at the request of AFSPC/SGPB and 45 AMDS/SGPB, conducted an acoustical evaluation of the Combat Arms Training and Maintenance (CATM) firing range at Patrick AFB, Florida. The process of assessing impulse noise at a CATM firing range is a very complex task using specialized equipment to assess hazardous noise environments. USAFSAM/OEC is the only AF Bioenvironmental Engineering resource with both the skilled personnel and equipment to accomplish these risk management/mitigation surveys. The purpose of this assessment was to determine the effectiveness of the engineering controls that were installed in the facility, as well as to classify the measured noise exposure as continuous or impulse; explain how the classification pertains to AFOSH Standard 48-20, *Occupational Noise and Hearing Conservation Program*; and provide recommendations for mitigating exposure to hazardous noise.

b. *Survey Personnel:* Two Bioenvironmental Engineering Technicians, Consultative Services Division, USAFSAM/OEC.

c. *Personnel Contacted:*

- (1) Bioenvironmental Engineer, 45 AMDS/SGPB
- (2) Bioenvironmental Engineering Technician, 45 AMDS/SGPB
- (3) NCOIC, Combat Arms, 45 SFS/S4C
- (4) Combat Arms Instructor, 45 SFS/S4C

d. *Equipment:*

- (1) B&K PULSE Analyzer, Type 3560-B-140, SN 2588445
- (2) Larson Davis Microphone Pre-amplifier power supply, Type 2221, SN 0200
- (3) Larson Davis Microphone, Model # 2530, SN 1489
- (4) Larson Davis Microphone Pre-amplifier, Model PRM902, SN 3824
- (5) Quest Calibrator, Model # QC-20, SN QF8050050

2. BACKGROUND:

a. The Patrick AFB CATM range is a fully enclosed, 100-meter-long firing range with 14 total firing lanes (see Figure 1). The range is used to train personnel on M4, M9, M11, M870, M240, and M249 weapons firing. A noise-reverberant field occurs during firing where the noise energy is reflected off the ceiling, walls, and floor surfaces, thereby increasing noise levels for a longer duration. Down range of the firing line is a series of steel safety baffles covered with plywood on the ceiling that are designed to deflect stray bullets and prevent bullets from leaving the range. These panels are closely spaced, thereby reflecting acoustical energy and increasing the duration of noise levels.



Figure 1. Patrick AFB CATM Range Lanes 1-14

b. During this assessment, data were not collected for the M249 machine gun because the ammunition required is a special order item and was not available.

c. Engineering controls were added to the CATM firing range facility in 2012 in accordance with Engineering Technical Letter, 11-18: Small Arms Range Design and Construction, para 7.2.9 through 7.2.9.4. These controls include sound-absorbing material added to the side walls from the red firing line back to the rear wall, and the back wall, as shown in Figure 2.



Figure 2. Patrick AFB CATM Sound-Absorbing Material

d. According to AFOSH Standard 48-20, the maximum level of **continuous noise** that is allowed to reach the ear shall not exceed 115 dBA, and the maximum level of **impulse noise** that is allowed to reach the ear shall not exceed 140 dB peak sound pressure level (SPL).

3. METHODOLOGY:

a. *Process Description:* The CATM firing range is used to train and qualify base personnel on multiple weapons systems. The firing range has two distinct painted floor lines that are used for reference. The first point of reference is the yellow safety line. Students must stand behind this line while not actively firing a weapon. The second point of reference is the red firing line, which is located 5 feet forward of the yellow safety line. The red line is where each student actively fires a weapon at a down-range target. During live-fire weapons training classes, instructors are positioned along the yellow line to ensure the range is safe and to assist students when needed. During this assessment, CATM instructors were observed wearing dual hearing protection (Peltor Optima 101 earmuffs and Sound Guard earplugs).

b. *Sample Procedure:* The SPL time histories corresponding to individual M4, M9, M11, and M870 weapons firings were measured with a ¼-inch microphone placed 5 feet above ground level along the yellow safety line; see Figure 3 for microphone positions. SPL time history data for the M240 machine gun were collected while two CATM instructors separately fired 500 rounds each. During this portion of the assessment, the CATM instructors fired from a position 25 meters down range of the red safety line and placed their target at approximately 35-40 meters down range. This was done to minimize damage to the plywood covering the overhead baffles. While conducting M240 qualification, the CATM instructor that wasn't actively firing the weapon provided guidance and oversight while positioned to the shooter's left; therefore, the microphone was positioned as close to the instructor as possible and approximately 5 feet above the ground; see Figure 3 for M240 microphone position.

c. Time histories are measured SPLs over a duration of approximately 4 seconds. This duration provided sufficient time to characterize the decay of the acoustical energy to background levels. These time histories were then used to compute acoustical decay characteristics.

d. The linear SPL decay rates, in decibels per second, were computed by selecting the linear decay phase of each time history and performing a sound level versus time analysis through the decay phase. Decay times are calculated from the linear slope from 150 dB down to 80 dB. The slope of this curve is the decay rate.

e. SPL time history data were collected in six phases to represent the spectrum of exposure scenarios typical at these ranges.

(1) During the first phase, 14 base personnel each shot an M4 on firing lanes 1-14 and 10 SPL time histories were collected at each microphone position.

(2) For the second phase, 14 base personnel each shot an M9 on firing lanes 1-14 and 5 SPL time histories were collected at each microphone position.

(3) The third phase of data collection was accomplished while one CATM instructor shot the M4 from firing lane 8 and 10 SPL time histories were collected at each microphone position.

(4) During the fourth phase, one CATM instructor fired an M11 from firing lane 7 and 5 SPL time histories were collected at each microphone position.

(5) The fifth phase of data collection was accomplished while one CATM instructor shot the M870 from firing lane 8 and 2 SPL time histories were collected at each microphone position.

(6) For the sixth phase, M240 data were collected while 2 CATM instructors separately fired 500 rounds from a position 25 meters down range of firing lane 12. Due to the rapid firing rate of the M240, 25 total SPL time histories were collected during this phase.

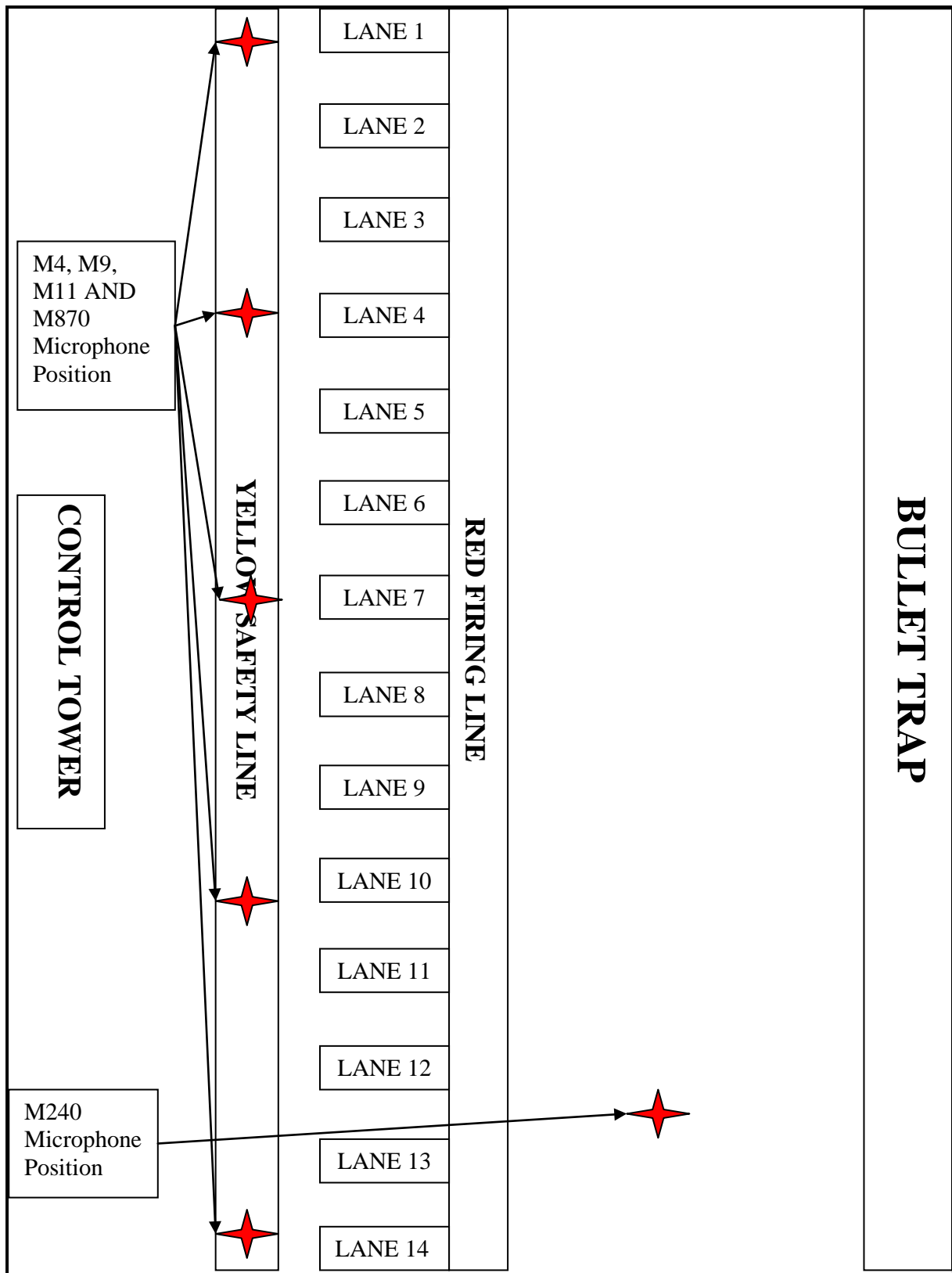


Figure 3. Patrick AFB CATM Firing Range Layout and Microphone Positions

4. RESULTS:

a. Under the monitored conditions of this assessment, the average noise decay times of each of the weapons fired were each greater than 1 second with peak SPLs greater than 115 dB; therefore, the noise is classified as continuous. According to AFOSH Standard 48-20, Table 3, there is no allowed exposure time above 115 dBA.

b. The average decay time and noise characterization of the five different types of weapons are summarized in Table 1.

Table 1: Noise Characterization by Decay Time

Weapon System/Class Type	Average Decay Time (s)	Noise Characterization	Maximum Unprotected Continuous Noise Level (dB)	Exceeds Continuous Noise Std. (Yes/No)
M4 class	3.0	Continuous	115	Yes
M4 single shooter	3.0			
M9 class	2.3			
M11 single shooter	1.9			
M870 single shooter	3.4			
M240	3.6			

5. CONCLUSION:

a. The in-place engineering controls installed at the Patrick AFB CATM range do not reduce the decay time of gunfire noise from continuous to impulse noise.

b. The noise data that USAFSAM/OE was unable to obtain for the M249 do not change the classification of the noise in this range. Prior impulse noise surveys at other CATM ranges have shown that an M249 typically has a higher peak SPL than an M240, and decay times are very similar to an M4 or M16.

6. RECOMMENDATIONS:

a. **Install sound-absorbing material to reduce the reverberant field.** The reverberant field in the range should be minimized to reduce the noise level to protect instructors and students from hazardous noise exposure and to improve speech intelligibility.

(1) Treat the firing area's first overhead baffle, the ceiling, and side walls from the red line back to the rear wall, as well as the the rear wall, with acoustical absorption material. Quilted fiberglass, or other fiberglass panels wrapped in a manner allowing easy cleaning, is one option. There are also more fixed installation materials available, such as products offered by Pyrok or Troy Acoustics. The goal of the sound-absorbing material is to change the noise classification from continuous to impulse noise by reducing the noise decay time to less than 1 second as well as reducing peak SPLs below 140 dB, in accordance with AFOSH Standard 48-20, para 2.11.3.1. The previously installed sound-absorbing materials should not be removed if additional sound-absorbing materials are installed.

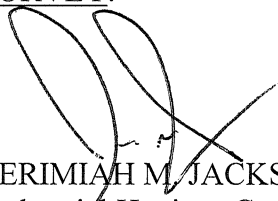
b. Both CATM instructors and students should continue to wear dual hearing protection (Peltor Optima 101 earmuffs and Sound Guard earplugs) during all live firing at the range.

c. Until effective engineering controls can be implemented, consider close scrutiny to audiograms as defined AFOSH Standard 48-20, 2.12.3 for all CATM instructors, as they **are not** adequately protected in the current range configuration with personal protective equipment and administrative controls.

d. CATM instructors should provide just-in-time training to students on proper use of hearing protection devices as part of classroom instruction. NIOSH has a short video on proper insertion of foam ear plugs available for download at <http://www.cdc.gov/niosh/mining/products/movies/rphhi.wmv>.

e. Request a USAFSAM follow-up noise assessment after acoustical treatment of the range is complete.

7. If you have any further questions regarding this report, please contact TSgt Jerimiah Jackson at DSN 798-3312 or jerimiah.jackson@us.af.mil. Please direct any questions or comments regarding Industrial Hygiene Consultative support to Maj Alan Hale at DSN 798-3862 or alan.hale@us.af.mil. To improve our services, please complete the critique located at <https://www.surveymonkey.com/s/OECUSTOMERSURVEY>.



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